

CARNIVOROUS PLANT NEWSLETTER

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Front Cover: *Sarracenia* 'Přemysl Otakar I'. Photo by Miroslav Srba.
Article on page 40.

Back Cover: *Dionea* 'Scarlet Bristle' trichomes (trigger hairs). Photo by Richard Keehn. Article on page 37.

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ICPS, Inc.
PMB 322
1564-A Fitzgerald Drive
Pinole, CA 94564-2229, USA
icps@carnivorousplants.org

President	Michael Baldwin, michael@carnivorousplants.org
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Editors:	
Managing Editor	Bob Ziemer, bob@carnivorousplants.org
Science Editor	Jan Schlauer, jan@carnivorousplants.org
Science Editor	Fernando Rivadavia, fernando@carnivorousplants.org
Editor	Barry Rice, barry@carnivorousplants.org
Graphic Design	Kandid Graphics, info@kandidgraphics.com

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FROM THE EDITOR

As the new Managing Editor of CPN, I want to thank Stephen Davis for managing the past 5 issues of CPN.

CPN has been the crown jewel of the ICPS for 38 years. At one time, CPN was essentially the only source of information about carnivorous plants. Today, there are many forums and web sites dedicated to carnivorous plants, including the ICPS web site and ICPS Forum. Our business and membership functions are now web-oriented. The ICPS Internet presence has recently expanded to YouTube and Facebook.

With all of this information increasingly available on the Internet, why continue printing CPN? We have been asking ourselves this very question. In October 2009, we sent a mass mailing to the ICPS membership asking the relative importance of print, electronic, or both versions of CPN. Only 7% reported that the print version was unimportant. We routinely produce both print and electronic versions (PDF) of each issue of CPN. In addition, PDF versions of all issues of CPN are available to ICPS members on our web site. We were surprised that 2/3 of the survey respondents said they did not know how to access the electronic version from our web site. We hope we have now improved access instructions at <http://www.carnivorousplants.org/cpn>

Bob Ziemer

Managing Editor CPN

bob@carnivorousplants.org

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an exclusive member benefit

The International Carnivorous Plant Society offers its members exclusive access to a variety of carnivorous plant seeds. Seeds are ordered online at the ICPS Store:

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1564-A Fitzgerald Drive, PMB 322
Pinole, CA 94564-2229

JOHN BRITTNACHER, Seed Bank Manager, john@carnivorousplants.org

NEW CULTIVARS

Keywords: cultivar: *Dionaea* 'Korrigans', *Dionaea* 'Scarlet Bristle', *Sarracenia* 'French Kiss', *Sarracenia* 'Orange Fire', *Sarracenia* 'Bordeaux Red Wine', *Sarracenia* 'Přemysl Otakar I', *Sarracenia* 'Rudolf II', *Byblis liniflora* 'David', *Dionaea* 'Korean Melody Shark'

Dionaea 'Korrigans'

Submitted: 13 October 2009

I found *Dionaea* 'Korrigans' in a garden center on 17 October 2007. The trap is fused with the petiole on all traps during the entire year (see Figures 1 and 2). Because of this fusion, the traps do not close well and the captured prey can sometimes escape. It's a very vigorous *Dionaea* and it divides many times each year. The color inside the traps is green and sometimes slightly red.

I have given the name Korrigans to this *Dionaea* because of the fusion between the petiole and the trap. Korrigans, here in Brittany, are little strange characters who have a human top of the body fused with animal legs. On this *Dionaea* cultivar, the trap part, which could fancifully be thought of as animal-like, is fused with the more mundane and vegetable-like part – the petiole.



Figure 1: *Dionaea* 'Korrigans' plant.
Photo by Guillaume Bily.



Figure 2: *Dionaea* 'Korrigans' fused trap and petiole. Photo by Guillaume Bily.

— GUILLAUME BILY • Le Ganquis • 56700 Kervignac • France • gbily2003@yahoo.fr

Submitted: 15 July 2009

The 'Scarlet Bristle' (see Figure 3) is distinct in its attributes as the leaf blades and traps exhibit scarlet to burgundy coloration in filtered sunlight and are held prone to the surface of the growing medium in all seasons of growth. The marginal trap cilia are greatly reduced, irregular and devoid of fine hairlike tips which imparts a rough bristly appearance to the trap lobe margins. This is clearly different in structure from the 'Red Piranha' as the triangular shaped marginal cilia are commonly uniform and evenly spaced on the 'Red Piranha'. Another interesting characteristic of the 'Scarlet Bristle' is that mature trap trichomes (trigger hairs) continue to develop a thick bristly growth on their upper portion as the traps age (see Back Cover). Although absent in young plants this unique attribute is very apparent in older plants, is readily visible to the naked eye and can resemble anything from a spear-head shape to the bristle end of a bottle brush. This extra growth on the trichomes appears to neither impede nor enhance trap function but does make itself worthy of continued study. Unlike the 'Bohemian Garnet' the 'Scarlet Bristle' grows equal in size to the regular form of *Dionaea* and does not produce copious numbers of offshoots after the plants have grown out of their TC vigor.

This cultivar was first discovered in the spring of 2006 while performing a replate of typical *Dionaea* tissue cultures. One small clump of plants caught my interest as it exhibited much red coloration to the trap lobes which was a contradiction to the uniform green that was always observed with that particular form of *Dionaea* under lab conditions. Upon closer inspection it was also noted that the marginal cilia on the traps was short and jagged in contrast to the cilia of other plantlets in the culture. As these particular *Dionaea* cultures had been maintained over the course of a few years on a basic 1/2 MS medium with no added PGR's one can only conjecture that the mutation developed through the multiple divisions that took place over that time. With great interest the specimen was isolated and propagated in sterile culture, planted out and hardened under artificial lighting followed



Figure 3: *Dionaea* 'Scarlet Bristle' plant. Photo by Richard Keehn.

by transfer to the greenhouse to be grown out. In the first year out of TC the ‘Scarlet Bristle’ remained predominantly green under artificial lighting but was quick to turn completely red when exposed to sunlight. During the first few months in the greenhouse the plants also exhibited much TC vigor by continuing to multiply by offsets. Although this was beneficial for obtaining a large number of plants, very few of the plants that were produced that first season achieved a size that was worthy of note and were left to go through dormancy so that developments could be observed in the next season. After 4 months of dormancy the plants were divided and grown separately at which time they displayed a tendency for increasing individual plant size instead of multiplication. It was in this second year out of TC that the more robust plants from year one confirmed the prone growth and enlarged trichome characteristics of the ‘Scarlet Bristle’.

Published online in Home Tissue Culture Group Newsletter 1(2): 11, December 2009 (<http://www.hometissueculture.org/htcgnewsletterDec2009.pdf>); reprinted with permission.

Abbreviations used: MS (Murashige and Skoog), PGR (plant growth regulator), TC (tissue culture).
Ed comment: the cultivar name to be registered is *Dionaea* ‘Scarlet Bristle’. (JS)

— REAL KEEHN CONCEPTS • C/O Richard Keehn • Lumby, BC V0E 2G5 • Canada • rkconcepts@telus.net

Sarracenia ‘French Kiss’

Submitted: 19 November 2009

Sarracenia ‘French Kiss’ is a hybrid between *Sarracenia oreophila* and *S. leucophylla* made in 1998. At the beginning of the growing season it looks like an ordinary *S. leucophylla* with a green pitcher tube and a white spotted lid. Later on, the pitchers get much taller and become very colorful; the spots on the lid being brightly white and the throat having a solid red/pink color (see Figure 4). The pitcher tubes are 60 to 70 cm tall.

The name was derived from the form of the peristome. It reminded me of a mouth and suggested the cultivar name *Sarracenia* ‘French Kiss’.

Vegetative propagation is necessary to maintain the unique features of this hybrid.



Figure 4: *Sarracenia* ‘French Kiss’ pitchers. Photos by Cédric Azais.

— CÉDRIC AZAIS • “buros” • 47200 Marcellus • France • azais.cedric@neuf.fr

Sarracenia ‘Orange Fire’

Submitted: 19 November 2009

Sarracenia ‘Orange Fire’ is hybrid discovered by Gerd Bachert in a German garden center in 2005. At the beginning of the growing season the pitcher tube has some orange veins and a copper red lid. As the season progresses, the new pitchers become a very intense orange, like fire (see Figure 5). For this reason, we named it *Sarracenia* ‘Orange Fire’. The pitcher tubes are of medium size, 40 to 50 cm tall. The flower is yellow/red.

Vegetative propagation is necessary to maintain the unique features of this hybrid.



Figure 5: *Sarracenia* ‘Orange Fire’ pitchers. Photo by Cédric Azais.

— CÉDRIC AZAIS • “buros” • 47200 Marcellus • France • azais.cedric@neuf.fr

Sarracenia ‘Bordeaux Red Wine’

Submitted: 19 November 2009

Sarracenia ‘Bordeaux Red Wine’ is a hybrid between *Sarracenia leucophylla* and *S. rubra* subsp. *gulfensis*. The pitcher tube is 60 to 70 cm tall. The tube is green with a veined top, and the pitcher throat is wine red (see Figure 6). The name was inspired by a friend who saw the plant and told me it looked like a glass of red wine and also because Bordeaux is my native country. The cultivar name *Sarracenia* ‘Bordeaux Red Wine’ is thus particularly appropriate because Bordeaux wine is world famous.

Vegetative propagation is necessary to maintain the unique features of this hybrid.



Figure 6: *Sarracenia* ‘Bordeaux Red Wine’ pitchers. Photo by Cédric Azais.

— CÉDRIC AZAIS • “buros” • 47200 Marcellus • France • azais.cedric@neuf.fr

Submitted: 1 February 2010

Sarracenia 'Přemysl Otakar I' was selected from the cross *Sarracenia leucophylla* × (*purpurea* × *leucophylla*) performed on 23 August 1999 (seeds collected 23 April 2000). The seed parent was a low quality clone of *S. leucophylla* that produced such narrow and uninteresting pitchers that it was subsequently eliminated. Pollen was taken from my favourite clone of *S. purpurea* × *leucophylla*. The origin of this pollen clone is uncertain; the only available information is that seeds were imported to our country in the late 1980s from Hungary. Based on flower colour and stalk height, the seed parent plant was most likely *S. purpurea* subsp. *purpurea*.

During the second year, when the seedlings were about 7 cm tall, one blazed like a jewel among the others. This seedling maintained its quality during subsequent years and even improved its colouration.

The cultivar's pitchers are 50–60 cm tall and 4–5 cm wide in their upper part (see Front Cover and Figure 7). The lid is about two times broader than the tube, with a maximum observed width of 10 cm. The lid is upright, flat, and semicircular in shape. The margin of the lid is finely undulated, similar to *S. leucophylla*. The most outstanding quality of 'Přemysl Otakar I' is its intense and contrasting colouration. The upper part of the pitcher is red-violet with remarkably strong veining that is an extremely deep maroon similar to the colour of black cherries. The white fenestrations contrast gorgeously with the maroon venation. The flower is similar to that of *S. leucophylla* in shape and colour (see Figure 8).



Figure 7: *Sarracenia* 'Přemysl Otakar I' pitcher.
Photo by Miroslav Srba.



Figure 8: 'Přemysl Otakar I' flowers.
Photo by Miroslav Srba.

Table 1: Differences of *Sarracenia* ‘Přemysl Otakar I’ from similar cultivars.

Cultivar	‘Přemysl Otakar I’	‘Kateřina’	‘Juthatip Soper’
colouration	Pitcher with white fenestration interlaced by strong venation. The tone of the veins is deep maroon. Freshly opened pitchers are similar to that of <i>S. leucophylla</i> in colour. Senescent pitchers are almost completely maroon.	Freshly opened pitchers are pink, later all red. Fenestration is completely covered by red pigments.	Pitchers red-pink, fenestration covered by red pigments. Young pitchers intensively fenestrated.
lid	Upright, flat, semicircular in shape; 2 × broader than peristome.	Lid almost horizontal; about same width as the peristome.	Skew lid, almost triangular in shape; about 1.5 × broader than peristome.
pitcher length	50–60 cm	60–70 cm	30–40 cm
peristome width	50–60 cm	60–70 cm	30–40 cm

Cultivation is the same as with other *Sarracenia*. This cultivar is moderately winter-hardy. Plants grown in 10 cm pots survived –5°C without damage. The plants produce a remarkably rich abundance of roots similar to some clones of *S. flava* × *leucophylla*. As a result, small rootless or poorly rooted cuttings can be established easily. *Sarracenia* ‘Přemysl Otakar I’ must be propagated vegetatively to maintain its characteristics.

The name of the cultivar is dedicated to Czech King Přemysl Otakar I (Ottokar I of Bohemia in English textbooks) who governed Bohemia from 1192-1193 and 1197-1230. This monarch is credited with establishing the internal stabilization of Bohemia and strengthening the political, religious, and cultural independence of the Czech Kingdom within Europe and especially of the Holy Roman Empire. My first registered *Sarracenia* cultivar is dedicated to the man in whose name is also epithet “the first”. The plant is remarkably slender and tall in its physique, as was King Přemysl Otakar I. The King was an outstanding and gorgeous personality of Czech history as the plant is among other plants in any grower’s collection.

— MIROSLAV SRBA • Želivského 1970 • 430 02 Chomutov • Czech Republic • srba@sarracenia.cz

Sarracenia ‘Rudolf II’

Submitted: 1 February 2010

Sarracenia ‘Rudolf II’ is a selection from the complex cross *Sarracenia* (*purpurea* × *leucophylla*) × *minor* var. *okefenokeensis*. This was my beginner experiment breeding *Sarracenia* (pollinated in May 1996, seeds collected 22 September 1996), which I performed as a teenage grower. The seed parent was the same clone of *S. × mitchelliana* that served as the pollen donor for *Sarracenia* ‘Přemysl Otakar I’, and the pollen parent was a clone of *Sarracenia minor* var. *okefenokeensis* donated by Dr. Miloslav Studnička. I expected that the hybrid’s appearance would resemble a robust *Sarracenia minor* with a raised lid and enhanced colouration.

One particular seedling from the cross, when about 10 cm in size, seemed to be typical except for one remarkable detail which caught my eye - white dots were unusually distributed near the edge of the lid, which otherwise lacked the fenestrations found in *S. minor* (see Figure 9). I had never seen such a fenestration pattern before. This seedling increased in colour and size during subsequent years.

The first spring pitchers on mature plants are about 70 cm tall. Later pitchers are 10–20 cm smaller, but are more robust and better coloured. The peristome can be 6–7 cm broad and the maximum width of the lid is 13.5 cm. The lid is shell-shaped, intensively veined, and fine-haired on the bottom side. Pitchers of plants well exposed to the sun become all red, except for the basal third which usually

stays green. Fenestrations are concentrated on the posterior side of the pitcher, as in *S. minor*; but the areoles are just smaller. Pitcher colour can change to a green surface with pink areoles during low light levels and cold stress during the winter. Some growers like this unique pattern. The plants form well-coloured and remarkably robust pitcher-rich clumps (see Figure 10).

Although the plant is a showstopper during the summer exhibitions, it is also superb in the spring due to its flowers, which are 6–8 cm in diameter and held on 60–80 cm tall stems. The superior (exposed) surfaces of petals and sepals are maroon, while the inferior (hidden) surface is yellow (see Figure 11). The umbrella-shaped style is green. Light yellow basal parts of petals form a consistent band surrounding the flower which is in great contrast to its maroon colour. Sepals and petals are remarkably solid and regularly shaped. Taken together, the quality of the *Sarracenia* 'Rudolf II' flowers exceeds those of similar bicoloured hybrids, especially in colour and shape. They are very suitable as cut flowers, thanks to the tall, strong, and straight stems.

The cultivar is a robust grower similar to *S. minor* var. *okefenokeensis* or *S. × mitchelliana*. It is highly resistant to rhizome rotting, thanks to the *S. minor* var. *okefenokeensis* influence. Thin and long bases are frequently unable to hold very heavy pitchers, so affixing of the clump is sometimes necessary. This is improved when the plants are grown separately in full sunlight and a well-ventilated place. The cultivar can be maintained in huge clumps, but the pitchers are larger and better coloured when plants are grown separately. The capsules contain numerous (500-1000), large and highly viable seeds. Offspring of the cultivar are also vigorous and usually attractive in their colouration.

The cultivar is named after Rudolf II, King of Bohemia and Holy Roman Emperor, who governed Czech countries during 1575-1611. Rudolf II was tall, robust, clad in colours, and a little bit cockeyed, similar to the appearance of this cultivar dedicated to him. Rudolf II greatly supported economical and cultural progress of the Czech Kingdom. During his period, Prague became a center of European cultural and scientific life, employing such personalities as Tycho Brahe, Johannes Kepler, Albrecht Dürer, Pieter Brueghel, Giuseppe Archimboldo, Edward Kelley, and John Dee. Rudolf II is considered to be a striking and positive personality of Czech history.



Figure 9: *Sarracenia* 'Rudolf II' pitcher detail. Photo by Miroslav Srba.



Figure 10: *Sarracenia* 'Rudolf II' plant. Photo by Miroslav Srba.



Figure 11: *Sarracenia* 'Rudolf II' flower. Photo by Miroslav Srba.

This cultivar is available in restricted quantity and can be obtained directly from me (srba@sarracenia.cz), Michael King, or Kamil Pásek.

— MIROSLAV SRBA • Želivského 1970 • 430 02 Chomutov • Czech Republic • srba@sarracenia.cz

Submitted: 7 March 2010

I purchased seed labeled *Byblis liniflora* from Rare Exotic Seeds on 12 February 2009. I soon discovered that the resulting plants possessed the same pulvinus anomaly that was first documented by *Byblis filifolia* 'Goliath' in 2008. However, this marvelous cultivar is much smaller (to 20 cm tall) and forms pulvinus on the leaf axils as well as the pedicels. Interestingly, pulvinus formation is unconditional and the leaves move downward to form a tripod-like support for the plant (see Figure 12). Another distinguishing factor is the existence of sessile glands on the shoot apex and leaves (see Figure 13). Branching is rare but does occur.



Figure 12: *Byblis liniflora* 'David' pulvini and sessile glands.



Figure 13: *Byblis liniflora* 'David' sessile glands.

Overall growing conditions have a great influence on the plant's flower structure. A comparison of sepal length to petal length unfortunately shows inconsistencies when compared to seedlings and clones in cultivation. The same inconsistencies exist when comparing filament to anther length. Anther coloration ranges from dark purple to light lavender, depending on the amount of sun received. Flower color ranges from light pink to dark purple. The back of the flowers range in color from white to tan or white with tan stripes. Striped and white flower forms are also known to exist. Equally important, overall growth habit and form is affected by lighting conditions, temperature differences, and moisture levels in cultivation. Therefore, one of the easiest ways to confirm that a plant is *Byblis liniflora* 'David' is the existence of unconditional pulvini and sessile glands.

Another important defining feature is that *Byblis liniflora* 'David' is self-pollinating and copious amounts of fertile seed are easily produced without any assistance, whereas *Byblis filifolia* 'Goliath' requires two genetically distinct plants for successful pollination.

Byblis liniflora 'David' can be reproduced from seed and cuttings, although cuttings have a low strike rate.

The name *Byblis liniflora* 'David' is coined from the well-known bible story of David and Goliath. The origin and meaning of the name is the same as in *Byblis filifolia* 'Goliath', except *Byblis liniflora* 'David' is much shorter, has sessile glands, and is self-pollinating. The leaves and pedicels move downward via pulvini unconditionally to support the plant in a tripod-like fashion.

— BRIAN BARNES • 991 Citrus Wood Court • Longwood, FL 32750 • USA • drosera5150@yahoo.com

Submitted: 26 March 2010

This cultivar was produced by crossbreeding different clones of plants known informally in the UK as *Dionaea* "Shark Tooth". The crossbreeding was done in the Korean Carnivorous Plant Institute by the head of the institute Dr. Jang Gi-Won and his intern Max Yoon.

The crossbreeding was not done with the intention of producing a new cultivar. Normally work at our Institute focuses on conservation. We are currently involved in a project to prevent certain Korean carnivorous plants from extinction. For instance, *Drosera rotundifolia* L. once lived in many regions of Korea. However, due to mass construction and exploitation without awareness of the importance of conserving carnivorous plants, many natural habitats have been destroyed. Therefore, in order to conserve Korean carnivorous plants, we have practiced mass propagation techniques of carnivorous plants. This new *Dionaea* cultivar was one unexpected result of our work.

By germinating 100 seeds after asepsis, one plant appeared to be different from the other ninety nine. We separated this unique plant and mass propagated it. It seems like this cultivar, which we named *Dionaea* 'Korean Melody Shark,' is a sterile mutant—after growing the cultivar and finally seeing its flower, we discovered that the pistil and stamen do not reach maturity. Therefore, we could not collect any seeds. It is thus only possible to multiply the cultivar by dividing the rhizomes.



Figure 14: *Dionaea* 'Korean Melody Shark'.

Dionaea 'Korean Melody Shark' and its parent plants are similar, but there are some important differences. First, the petiole of *Dionaea* 'Korean Melody Shark' remains very thin and narrow throughout (see Figure 14). Traps that are not yet fully grown look like bean sprouts. When the traps are fully grown, they become broader in shape. The sawteeth along the trap margin of *Dionaea* 'Korean Melody Shark' are broader, shorter, and are arranged in an irregular pattern compared to those of its parents (see Figures 15 and 16). Finally, while the parent plants remain green throughout, the inside of the traps of *Dionaea* 'Korean Melody Shark' are red.



Figure 15: *Dionaea* 'Korean Melody Shark' trap.



Figure 16: Parent plants of *Dionaea* 'Korean Melody Shark' from the UK informally named *Dionaea* "Shark Tooth".

We named this cultivar "Korean" because it came from Korea, where this new carnivorous plant cultivar has been named, "Melody" because the traps look like musical notes, and "Shark" as an allusion to the informal name of the parent plants.

- DR. JANG GI-WON • Korean Carnivorous Plant Institute • 107-6, SoungNae-Dong, GangDong-Gu • Seoul, 134-030 • Republic of Korea • jgw77@yahoo.co.kr
- WOOK HYON (MAX) YOON • Jinhung Apartment 7 Dong 104 Ho Gangnam-gu • Chungdam-dong • Seoul, 135-100 • Republic of Korea • mylifestyle_3@hotmail.com

NOMENCLATURE OF THE *DROSERA ANGLICA* COMPLEX REVISITED

Jan Schlauer (jan@carnivorousplants.org)

As noted before (Carniv. Pl. Newslett. 37:118-119, 2008), there can be only one legitimate name for all hybrids (including hybridogenic stabilized segregates) between two taxa at the rank that distinguishes the two parent taxa. In the case of *Drosera linearis* and *D. rotundifolia* as the parents (which are distinguished at species rank), this name is *D. anglica*. This has led to the relegation of the back-cross that has been known for a long time at the illegitimate rank of species (as *D. × obovata*) to a variety of *D. anglica*.

There are two further, naturally occurring hybrid taxa that involve the same parent species, viz. the primary, diploid hybrid that is usually sterile (as opposed to *D. anglica* var. *anglica* that is amphiploid and fertile) and that has been likewise named at the nomenclaturally inappropriate rank of species (as *D. × woodii*) and the back cross of *D. anglica* var. *anglica* with *D. linearis* that had first been created in horticulture before it was described from several localities in the wild. Also the latter has received a name at species rank (*D. × linglica*).

The purpose of this note is to validate the respective nomenclaturally acceptable (*i.e.* infraspecific) combinations for the above mentioned taxa. As both are usually sterile and not dominant over their respective parents, they depend on the presence of the parent taxa for their existence and persistence, leading to sympatric distribution, which is recognized by varietal rank by the present author.

Drosera anglica nothovar. *woodii* (Gauthier & Gervais) Schlauer *comb. & stat. nov.*

Basionym: *Drosera × woodii* Gauthier & Gervais, Acta Botanica Gallica 146: 395 (1999)

Drosera anglica nothovar. *linglica* (Kusakabe ex Gauthier & Gervais) Schlauer *comb. & stat. nov.*

Basionym: *Drosera × linglica* Kusakabe ex Gauthier & Gervais, Acta Botanica Gallica 146: 393 (1999)

The hybridogenic relationships within the *D. anglica* complex as presently known are illustrated in Figure 1.

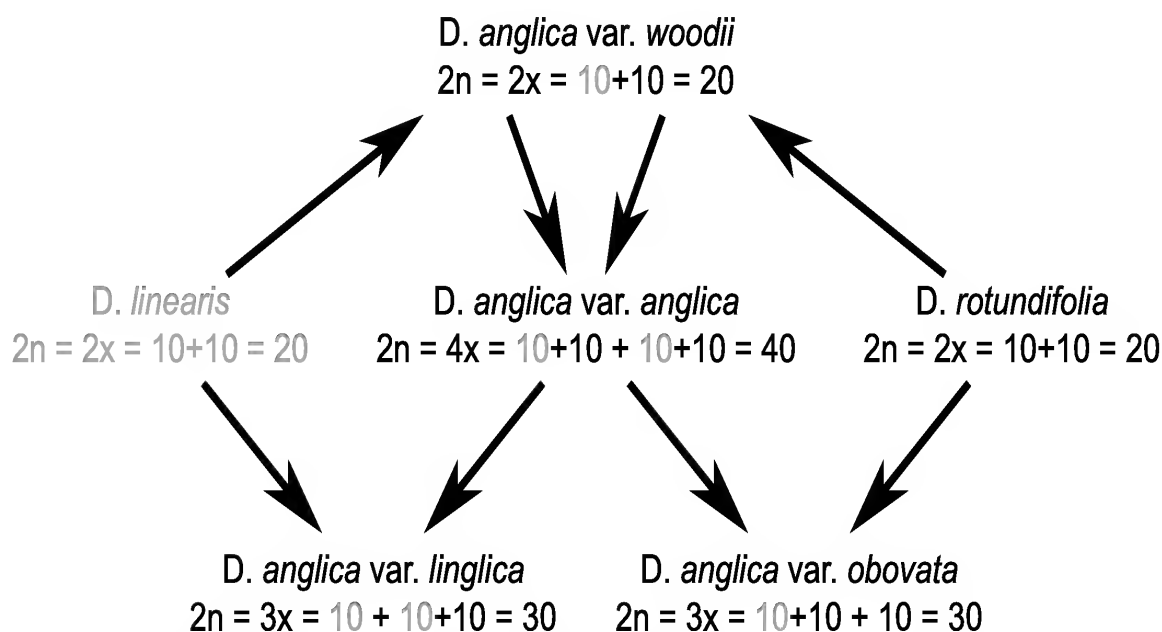


Figure 1: Hybridogenic relationships within the *D. anglica* complex. Somatic chromosome numbers are given with the level of ploidy and the specific complementary composition (the complement of *D. linearis* being printed in grey).

THE SAVAGE GARDEN: “LLOYDIE”

PETER D'AMATO • California Carnivores • 2833 Old Gravenstein Hwy • Sebastopol, CA 95472 • USA •
califcarn@aol.com

Keywords: biography: Francis Ernest Lloyd

It is almost hard to believe that nearly two generations passed – or 67 years – between the publication of Charles Darwin's *Insectivorous Plants* in 1875 and F. E. Lloyd's *The Carnivorous Plants* in 1942.

We all know who Chuck Darwin was. But who was Francis Ernest Lloyd? These days, with computers and the internet and a growing volume of popular and scientific books on carnivorous plants (CP), many younger hobbyists have never heard of Lloyd or read his famous book, not realizing that we all stand on his shoulders as we peer ever further into the constantly expanding world of these truly marvelous flora.

Those of us who are middle-aged and beyond, and who have had an interest in CP since an early age, are much more inclined to be familiar with Lloyd's seminal work. During and prior to the slow re-emergence of interest in these strange and haunting plants in the 1970s, there was scant information for the curious or obsessed. We had Darwin's work, a couple of National Geographic articles from the late 1950s and mid-1960s, one children's book (Lynn and Gray Poole's *Insect-Eating Plants* in 1963) and Rica Erickson's 1968 *Plants of Prey*, an obscure but beautifully illustrated book on CP of Australia.

But then there was Lloyd. His amazing scientific work carried forward Darwin's research to a mere 30 years prior. As a kid in high school, I devoured it many a time. But who was F. E. Lloyd? Some well-respected botanist of the days of old was all I really knew.

* * *

A few years ago a good-looking middle-aged woman came into my nursery, California Carnivores, and spent some time admiring our plants. After awhile she came up to me and said something like, “Hello. Your nursery is amazing! My name is Mardi Lloyd. I'm Francis Lloyd's granddaughter. Are you familiar with him?”

I almost fell out of my chair. My enthusiasm must have been rather explosive, because Mardi's excitement nearly matched mine. Francis Lloyd's granddaughter! I had a hundred questions for her and we chatted for quite awhile. I knew this was a chance to find out who the person of F. E. Lloyd was, a chance for him to become more than just a name on a book that I so admired. Later Mardi sent a framed photograph of her grandfather which sits in the nursery next to Darwin's. She was no doubt very proud of him. At that first meeting Mardi said, “Our family calls him Lloydie.” Lloydie. How cute. He was becoming more real already!

* * *

If Lloyd had been in a different line of science, I might use the adjective “astronomical” to describe his life's accomplishments. But here I can only be brief and highlight some of his life and work.

He was born in Manchester, England on October 4, 1868 to Welsh parents, who immigrated to the United States while Lloydie was but a tot. After finishing high school in Philadelphia he briefly was a dental assistant, apprentice watchmaker, and a “cow puncher” (I don't want to know what that is!). For awhile he became religious, perhaps feeling guilty after punching all those cows, and decided to enter the ministry and pursue his education at Princeton University in New Jersey. It was at Princeton that he converted to science and specifically botany.

After graduating in 1895, Lloyd went to Germany and did graduate studies in Bonn and Munich, where he befriended his teacher Karl Von Goebel. Much later, after Goebel died in 1932, Lloyd would dedicate *The Carnivorous Plants* to his mentor. Goebel himself was famous in botany for his work *Organography of Plants* where he argued that evolutionary forms followed a change in function. Goebel gave Lloyd an extensive herbarium of *Utricularia* he had collected in his world travels.

Lloyd returned to America and taught at several universities from Oregon to New York. At Columbia University he wrote a popular book on how to teach biology. While teaching, he published

many botanical papers on subjects like morphology and embryology. His interests varied, once writing about the creation of hailstones and how timbers rotted in coal mines.

Also at Columbia, Lloyd met and married Mary Elizabeth Hart, a fellow teacher of biology. More about Mary later.

Next, Lloyd pursued research. He went to the Carnegie Institute's Desert Laboratory in the Arizona Territory and later moved to Mexico, then wrote a monograph on "Guayule: a Rubber Plant of the Chihuahuan Desert". He would remain a consultant for the rubber industry for two decades. He also wrote "Physiology of Stomata" in 1908, which one reviewer called "notable not only for its positive contributions to the knowledge of the stomatal mechanism, but also for the iconoclastic glee with which the teleological assumption of perfect regulation of transpiration by stomata is discredited." My goodness, Lloydie was on a roll!

Lloyd ended up at McGill University in Montreal, Canada, where he chaired the botany department until 1934. What he enjoyed most was the mystery of plant physiology, and was noted to work in his laboratory until well past midnight, most often over a microscope. (This would later take its toll.) He made the first important motion pictures of the workings of *Utricularia* traps, which amazed his colleagues and so fascinated him, much of the years that followed were dedicated to the study of the bladderworts, and finally all the carnivorous plants. During his years at McGill, he was President of the Royal Society of Canada ("the highest recognition which the country of his adoption could award", wrote a colleague) and an honorary degree from the University of Wales ("which moved him most of all his honors, for he was a Welshman at heart."). He was the editor of *Plant Physiology* for many years as well.

Lloyd retired in 1934, took a world trip with his wife Mary, a retirement gift from his colleagues. During this long voyage he studied many carnivorous plants in the wild, from Africa to Australia. Upon their return, the Lloyds settled in Carmel-by-the-Sea in California. This was where he wrote *The Carnivorous Plants*.

* * *

For nearly forty years, *The Carnivorous Plants* remained the only popular scientific book on the subject, and it remains vivid, engrossing and very well written. Published as World War II was exploding, photographs were unfortunately reduced to small black and white pictures confined to the back of the book due to constraints in costs. Lloyd's own line drawings clearly illustrate details of cell structure and other things scientific, for this is a science book, not one on horticulture. Each chapter gives a brief introduction to the genus in question, then proceeds to review various scientific papers published by researchers over the previous decades, many by Lloyd himself and other well known botanists. From this he draws conclusions, and often raises many questions.

There are a few things particularly noteworthy in this book. One is that in his introduction, Lloyd dismissed *Roridula* from the group of carnivorous plants, since he could find no way for the plants to absorb nutrients without digestive enzymes. He was aware of assassin bugs and crab spiders living on the plants, as he discussed in his original paper *Is Roridula a Carnivorous Plant?*, and felt they deserved further study. We now know the plants absorb the fecal remains of these bugs. Another interesting highlight is his chapter on carnivorous fungi, a subject rarely seen in popular CP books. But it is his startling chapters on his true love, *Utricularia*, much of it based on his own detailed research, for which Lloyd is so well regarded. In the appendix of the chapter on the bladderwort trap, he offers an amazing illustration and step-by-step detail of the functioning of this "pretty complex bit of mechanism".

* * *

Francis and Mary had two sons, Francis Jr., known as Frank, and David, who went on to become a notable neurophysiologist at the Rockefeller Institution and a Rhodes Scholar. Frank had an interest in science, but never pursued it. He had four children: Jennefer, Skip, Cindy, and Mardi, the youngest. After Mardi's visit, and a return with her sister Cindy, I received friendly emails from them about memories and stories of their grandfather.

Cindy was six when Lloyd died in 1947, and offered some vivid early recollections of his retirement in Carmel. Mardi was much younger, but recalled stories from her parents.

"I recall pitcher plants growing outside the Lab's door. I used to think if I put my finger in one, it would bite me," Cindy later wrote. "He collected spiders kept in jars in the Lab," and she enjoyed shaking them to make the black widows move. She loved to play with his lab equipment, taking apart eye pieces and apertures of his microscope. "Never did he quell my curiosity or interest. One day I showed up naked for tea. He told Mom he never wanted me to change my uninhibited personality!" Cindy became a registered nurse and Master Gardener when she grew up.

Lloyd, on the other hand, always dressed formally, “wearing three piece suits daily,” Cindy recalled. “We would listen to opera on the radio and have afternoon tea.” Lloyd enjoyed performing in plays produced outdoors by a local civic group, once photographed in Indian dress. Their house was of dark wood, with a Steinway piano, grandfather clock, radio cabinet, and Persian rugs Lloyd collected in their travels, along with other heirlooms.

Mardi, who has a talent for lovely botanical and landscape art, told me Lloydie suffered from headaches, blamed on his hours of microscope work as he researched stomata and bladderworts and fungi. His wife Mary often read to him, to give his eyes a rest.

Mary Hart, as a biologist and teacher herself, shared Lloyd’s life and interest in the natural world. Lloydie was deeply in love with her, inscribing books to “Merrie Heart”. Grandson Skip described their relationship as “an interesting, loving and intellectual ride for both.”

One thing unknown to the public or in printed biographies on Lloyd, was that this was Lloyd’s second marriage. During the 1890s he married an “opera singer”, name unknown. This first marriage was brief. On a trip they took to Germany, she had a ship-board affair, and Lloyd divorced her.

Mardi also heard that her grandfather was known to shout and lose his temper at times. In a memorial written by a colleague, it was written: “He had the temperament of an emotional artist. Before every important lecture he was as nervous as an actor waiting to go on stage,” until the audience warmed up to him, “as they always did.” Once, at a Scottish memorial for the fallen of the First World War, he openly wept. “While his manner could on occasion be bluff and his feelings might be relieved by a ‘bawling out’ given in forceful language, his bark was far worse than his bite for he was essentially a kind man” known for “his personal charm, story telling, and utterance of drolleries which attracted a world-wide circle of friends”.

In 1947, five years after the publication of *The Carnivorous Plants*, Francis Ernest Lloyd passed on. He was 79 years old.

* * *

I would like to thank F. E. Lloyd’s grandchildren for their enthusiasm in helping me know the author of *The Carnivorous Plants* as a human being. California Carnivores’ volunteer and friend, Patrick Hollingsworth, provided much researched material. The memorial quotes were taken from an essay written by Dr. George W. Scarth of McGill University for *Plant Physiology*, Volume 23, page 1 (1948). Damon Collingsworth helped with technical matters.

The End



Figure 1: Goebel on the far left and Lloydie is second from the right.

COMPARATIVE MORPHOLOGICAL STUDIES OF TRANSPLANT
SARRACENIA PURPUREA L. (SARRACENIACEAE) POPULATIONS IN
MARYLAND, WEST VIRGINIA, AND PENNSYLVANIA

ADAM HNATKOVICH • West Virginia University • Department of Biology • Life Sciences Building • Morgantown, West Virginia 26505 • USA • ahnatkov@mix.wvu.edu

HONGQI LI • Frostburg State University • Department of Biology • 101 Braddock Road • Frostburg, Maryland 21532 • USA • hli@frostburg.edu

Keywords: *Sarracenia purpurea*, morphology, population, Allegheny, carnivorous

Abstract

At least eight populations of *Sarracenia purpurea* in western Maryland, West Virginia, and southwestern Pennsylvania were transplanted from Glade Run Bog, Pennsylvania in the 1940s, but their current status had been unknown. We have conducted population and morphological analyses of six of these transplant populations. Our results revealed significant variation in flower and pitcher morphology among populations. Morphological variation could be correlated with the physical and chemical environment that each population inhabits. Future research may reveal if morphological variation that is expressing among transplanted populations could be caused by environmental factors.

Introduction

Sarracenia purpurea is found throughout Canada and the eastern United States from Maine to Georgia (Schnell 1979, 2002). However, native populations of *S. purpurea* are continuously decreasing within the Allegheny highlands of Maryland, West Virginia, and Pennsylvania. The last native population of *S. purpurea* was found at Glade Run Bog, Pennsylvania, by Schrock in 1939. Unfortunately, Glade Run Bog was destroyed during the construction of High Point Lake (Somerset County, Pennsylvania) in the 1940s. Prior to the lake's construction, a number of *S. purpurea* individuals were transplanted into (at least) eight wetlands within the Allegheny Mountain region: Spruce Flats Bog (SFB) and Mount Davis Bog (MDB) in southwestern Pennsylvania, Rock Lodge Wetland (RLW) and Cunningham Swamp (CHS) in western Maryland, and Cranesville Swamp (CVS), Big Run Bog (BRB), Cranberry Glades (CRG), and Helmick Run Swamp in West Virginia (MacKenzie, pers. comm.). Prior to our investigation (see Hnatkovich 2007), the current population status and morphological profile of these transplant populations had not been quantified. It was necessary to investigate population size and morphological variation among populations to identify regionally unique and/or threatened ecotypes that may warrant further investigation and conservation. We hypothesized that after more than 60 years of geographical isolation, the transplant populations could vary significantly in terms of pitcher morphology and flower morphology.

Morphology of pitcher plant leaves (pitchers) is thought to be affected by certain environmental factors, such as pore-water nutrient availability (Ellison & Gotelli 2002; Ellison *et al.* 2004). Furthermore, the color, size, and shape of pitchers could be related to insect attraction (Newell & Nastase 1998). In our study, transplanted *Sarracenia purpurea* populations have originated from a single "source" population: this provides us with an unusual opportunity to comparatively study plant morphology in different wetland environments after an extended period of isolation. Populations were transplanted into wetlands that are dominated by different vegetative communities, and wetlands are located across a range of elevations and latitudes. Therefore, transplant locations could also be highly variable in terms of hydrologic cycles and/or availability of micro- and macronutrients. Most importantly, variation in environmental conditions among transplant locations could be associated with

variation in *S. purpurea* morphology and historical reproductive success. We have investigated six of the eight transplant *S. purpurea* populations, and detected significant differences among populations in regard to pitcher and flower morphology. Our estimates of population size suggest that each population could have experienced different historical reproductive success. In the future, it will be essential to identify environmental variables that affect *S. purpurea* population size, population and individual growth rates, and morphology in these transplant populations. By understanding the relationship between *S. purpurea* and its environment, it may be possible to develop more appropriate conservation strategies for regional *S. purpurea* populations within the Alleghenies.

Methods

Geographical characteristics of the six *S. purpurea* populations (SFB, MDB, BRB, RLW, CVS, CRG, Table 1) are based on Hnatkovich's thesis (2007). Data collection was conducted during late summer and early fall in 2006 (from September 15 to October 6). At each population, flower morphological data were collected from 20, randomly selected, flowering individuals (see Figure 1). For plants that had more than one flower, data were also collected from (up to) two additional flowers. From the smallest population at Cranesville Swamp, all flowering plants (14 individuals) were sampled. Flower data included calyx diameter, stigma umbel diameter, and pistil height (from receptacle to the stigma top). Mean calyx diameter, umbel diameter, and pistil height were calculated for each population (see Figure 1). It should be noted that flower morphological characters did not vary significantly within each population. Pitcher morphological data of the most fully developed, first-year pitchers were collected from 50 randomly selected individuals (see Figure 2). We calculated and compared the metrics relative mouth area, keel width, hood size, hood height, and hood area. Methods of calculating these metrics are discussed elsewhere (Hnatkovich 2007). These data may represent differences in pitcher-shape better than absolute measurements, and also could reflect the degree of expression of carnivorous structures (Ellison & Gotelli 2002; Ellison *et al.* 2004) among transplant populations.

Prior to statistically analyzing data, tests for normality of residuals, using the Kolmogorov-Smirnov, Anderson-Darling, Shapiro-Wilk, and Cramer-von Mises tests, were performed in SAS (SAS Institute, ver. 8.9). Levene's Tests for equal variances (not assuming a normal distribution) for each metric were performed in Minitab (ver. 13.2). Flower and pitcher morphological data were compared among populations using a One-Way ANOVA ($\alpha = 0.05$; SAS, ver. 8.9). Multiple comparison tests were performed in SAS (ver. 8.9; $\alpha = 0.05$) using Tukey's Studentized Range (HSD). Lastly, a Spearman's correlation test was performed in SAS (SAS Institute, ver. 8.9) to examine the relationship between relative keel width and relative mouth area metrics ($p = 0.05$), and among all relative metrics (Bonferroni adjusted; $p = 0.005$).

It should be noted that the metrics relative mouth area and relative keel width were derived (and in some cases adapted) from the work of Ellison *et al.* (2004; length: mouth diameter ratio) and Ellison & Gotelli (2002; relative keel size and relative tube diameter). However, these metrics may not be identical to those of Ellison & Gotelli (2002) and Ellison *et al.* (2004): mouth area, rather than mouth diameter, was used to calculate a metric to describe the relationship between the size of the pitcher opening and the length of the pitcher. Similarly, the locations on pitcher leaves from which we collected data to calculate our metric "relative keel width" may have deviated from those locations used by Ellison & Gotelli (2002) and Ellison *et al.* (2004): our keel-metrics may not represent the same relationships as the keel-metrics of other authors.

Results

Geographical characteristics of the six study wetlands (SFB, MDB, BRB, RLW, CVS, CRG) are provided in Table 1. Significant differences in the size of calyx diameters, stigma diameters, and pistil length were detected among populations ($p < 0.0001$). *Sarracenia purpurea* populations at Rock Lodge Wetland and Cranesville Swamp displayed the largest flowers. These populations' calyx diameters, stigma diameters, and pistil heights were significantly larger than all other populations, but were not

significantly different from each other within each population (see Figure 1). Significant differences among populations were consistent across all flower morphological characters. Cranesville Swamp and Rock Lodge Wetland displayed the largest flowers, while the remaining populations were ranked (largest to smallest) as follows: Mount Davis, Cranberry Glades, Big Run Bog, and Spruce Flats Bog (see Figure 1).

Comparisons of relative metrics of pitcher morphology revealed significant differences in the expression of carnivory ($p < 0.0001$) and hood morphology ($p < 0.0001$). Cranesville and Rock Lodge populations are not different when comparing all relative pitcher metrics, and displayed the largest relative mouth areas (largest expression of carnivory) of all populations (see Figure 2). Also, Spruce Flats Bog displayed the smallest relative mouth area, and the second largest relative keel widths (least expression of carnivory). Spearman's correlation test revealed a significant negative correlation between relative keel width and relative tube diameter ($p < 0.0001$). Also, there was a significant negative correlation between relative hood-surface area and relative keel size ($p < 0.0001$), and a significant positive correlation between relative hood-surface area and relative tube diameter ($p < 0.0001$).

Discussion

Significant differences in pitcher morphology among populations could represent the phenotypic plasticity of *Sarracenia purpurea*, rather than genetic divergence (Ellison & Gotelli 2002). A significant negative relationship between relative mouth area and relative keel width, as revealed by Spearman's correlation test, suggests that carnivorous structures are reduced as the non-carnivorous keel increases in width (see also Ellison & Gotelli 2002). The biological significance of variation in hood size and shape remains in question, as this form of morphological variation is not often discussed in the literature, and is probably a phenotypically plastic trait. From the above data, there are significant differences among populations in terms of relative hood size and area (see Figure 2), and considerable variation in approximate hood-surface area among populations (Hnatkovich 2007). There was a significant negative correlation between relative hood-surface area and keel size, and a positive correlation between hood-surface area and tube diameter. These data suggest that hood area is related to carnivory, and that hood area should increase as *S. purpurea* relies more heavily on carnivory.

According to Ellison & Gotelli (2002), the negative correlation between the relative keel width and relative tube diameter could be the result of the availability of certain nutrients. More specifically, increasing available nitrogen in soil could lead to increase in keel width and a decrease in the diameter of the pitcher-opening (Ellison & Gotelli 2002). In future studies of these transplant populations, the amount of available nitrogen and other limiting nutrients at these populations should be analyzed in the context of pitcher morphology. Determining the response of these transplant populations to N-availability may be of great importance in the Allegheny Mountains: according to Peterjohn *et al.* (1996), Pennsylvania, Maryland, and West Virginia have experienced some of the largest depositions of nitrogen in the eastern United States.

It may be possible that annual temperature regimes associated with elevation and latitude may affect each *S. purpurea* population's growing season length, rate of pitcher development, and the subsequent expression of morphological characteristics. Populations at higher elevations and higher latitudes experience lower annual temperature, which could result in a shorter growing season. Although we did not directly measure seasonal temperature variation among populations, we have noticed that new pitchers and flower buds emerged at different dates among these populations: new pitchers and flower buds emerged approximately two weeks earlier at Cranesville and Rock Lodge populations (during the summer of 2006) than at any other population. Surface-substrate, soil properties, parent-material, frost damage (Chapin & Pastor 1995), severity of winter, and lifting of a winter-formed ice-sheet during spring thaw (pers. obser.) may all be important governing factors of pitcher morphology during the growing season.

Cranesville Swamp and Rock Lodge Wetland populations displayed the largest flowers of all transplant populations (see Figure 1). We have not encountered any published literature that report variation in flowers in *S. purpurea* populations in the context of environmental variables (*i.e.* nutrient availability). While we cannot infer (with any certainty) that differences in environmental variables among wetlands are responsible for differences in flower size, we do not disregard this possibility. We have experimentally transplanted several *S. purpurea* individuals from Mount Davis Bog to Frostburg State University’s greenhouse, and also to a controlled, outdoor location. However, flowers of these plants have not become noticeably larger after two years (Li, unpub. data).

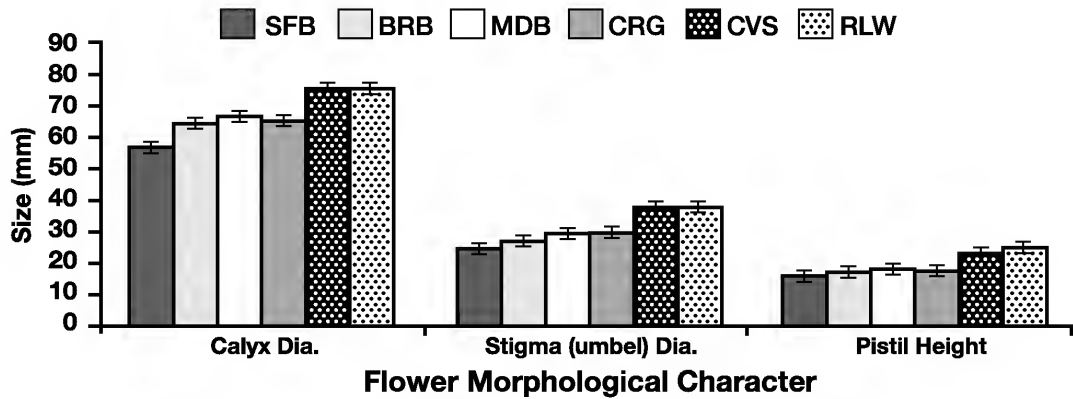


Figure 1: Mean calyx diameter (mm), mean stigma diameter (mm), and mean pistil height (mm) of *Sarracenia purpurea*, with standard error bars.

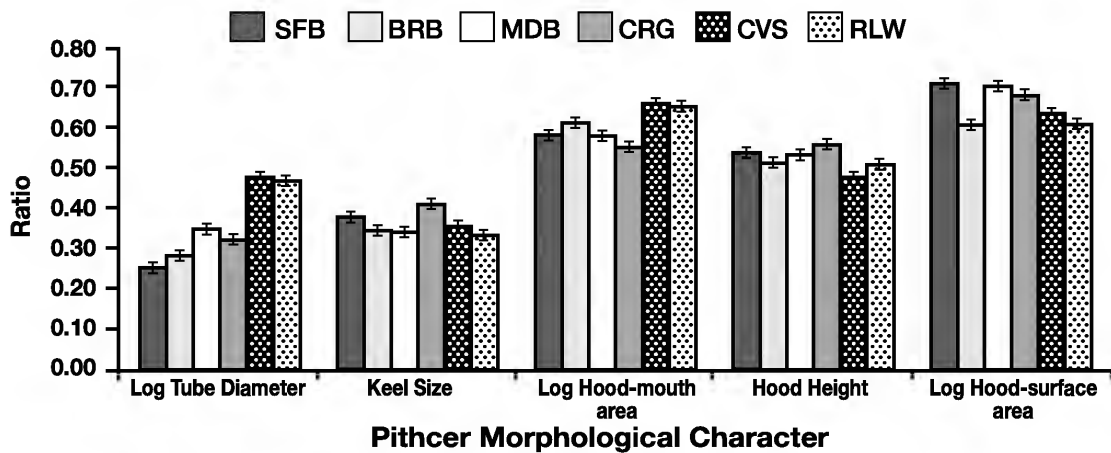


Figure 2: Mean relative metrics of *Sarracenia purpurea* with standard error bars.

It is also possible that differences among transplant populations’ flower morphology are representative of genetic differences among populations. However, it is difficult to infer this relationship without genetic information from our transplant populations and the historical founders of each population (representative of Glade Run Bog). Because the *S. purpurea* population at Glade Run Bog was isolated for an unknown number of generations (thought to be the last native population in the region; Mackenzie, pers. comm.) prior to the transplant-events, it is possible that genetic variation had been drastically reduced as a result of genetic drift or other evolutionary mechanisms. Additional historical data has been provided by the Westmoreland County Botanical Society (pers. comm.) regarding the transplant event at Spruce Flats Bog. These historical data suggest that the number of founding individuals at Spruce Flats was less than 20. As of 2006, the estimated population size of *S. purpurea* at Spruce Flats Bog was approximately 157,000 adults (flowering and non-flowering) and 213,000 seedlings (Hnatkovich 2007). Additionally, all transplant events were conducted by the same individuals (MacKenzie, pers. comm.; see also Hnatkovich 2007). Because of the extremely small *S. purpurea* population sizes at Cranesville Swamp (32 plants), and Cunningham Swamp (approx. 200

adult plants), we suggest that all transplant populations could have developed from a small number of initial individuals (Hnatkovich 2007): this could have resulted in a founder effect at each population, leading to reduced genetic variation in contemporary populations. After 60 years, with hypothesized differences in population growth rates among populations (Hnatkovich 2007), we may expect these populations to be genetically dissimilar as a result of reproductive isolation.

Table 1: Summary of *Sarracenia purpurea* population characteristics.

Location	Approximate Elevation (m)	Latitude (UTM, NAD27)	Approximate land-area occupied by <i>S. purpurea</i> (ha)	Estimated population size
CRG	1028.7	563652	0.25	130 (census)
		655565		
SFB	829.1	(NAD83)	2.5	287,544
		655327		
MDB	979.3	622565	0.75	17,000
BRB	979.9	645640	2	327,217
RLW	804.7	630383	0.25	1441(census)
CVS	780.3	645640	0.25	32 (census)
CHS	780.3		1	200

Update: In 2009, the land manager decided that the transplanted pitcher plants were not natural in Cranesville Swamp and dug them out completely.

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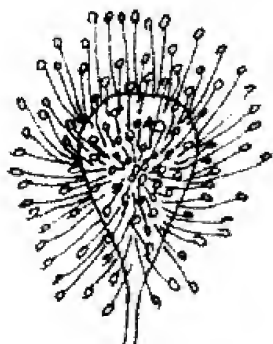
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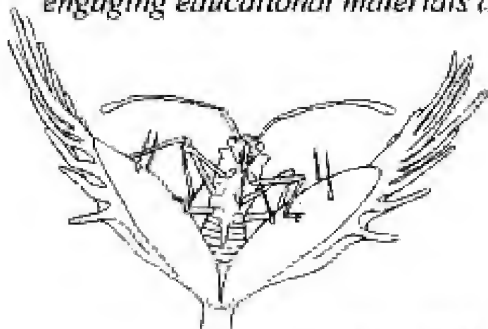
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OBSERVATION OF REPRODUCTIVE ORGANS OF SARRACENIACEAE WITH SEM LV MODEL

HONGQI LI • Department of Biology • Frostburg State University • Frostburg, Maryland • USA • hli@frostburg.edu

Keywords: LV SEM, *Sarracenia*, *Darlingtonia*, *Heliamphora*, pollen, seeds

Abstract

The High Vacuum (HV) model of Scanning Electron Microscope (SEM) is commonly used to observe specimens coated with metal or carbon. To simplify the procedure and reduce the cost, we used the Low Vacuum (LV) model of Joel SEM to directly observe anthers, pollen, and seeds of *Sarracenia*, *Darlingtonia*, and *Heliamphora*. For the first time, these reproductive organs are recorded with SEM. We also compared their morphological similarities to test their inter-general affinities.

Introduction

Commonly, a HV model of SEM is used to observe morphology of small specimens that were previously coated with carbon or gold. However, recently some SEM (e.g., Joel) has been produced with a LV model allowing one to directly observe specimens, such as metal, china, plant leaves, pollen, seeds, feather, and insects (Symondson & Williams 1997), only if the sample surface is dense enough to reflect sufficient electron beams to be converted into images. Without coating specimens, the LV model is much more convenient and cost-saving than the HV model.

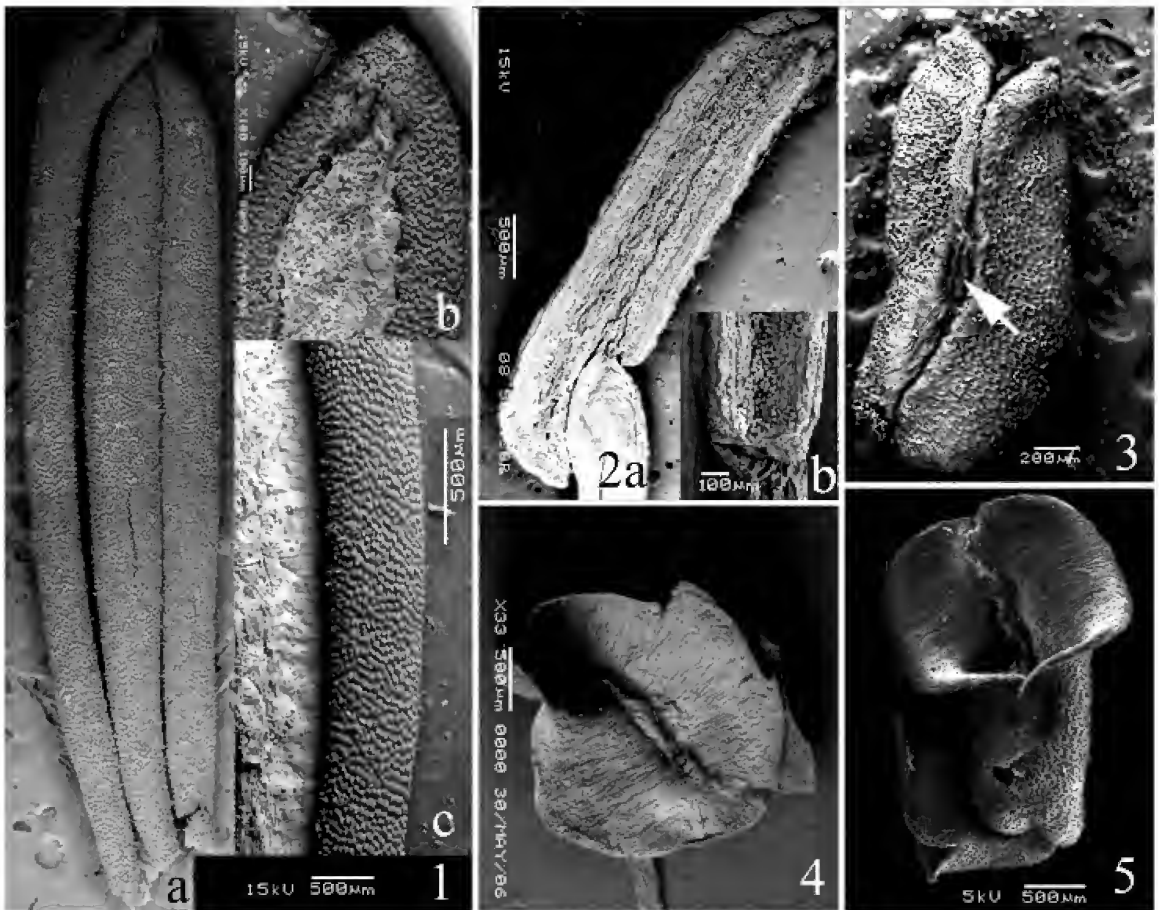
Sarraceniaceae include three genera, *Heliamphora* in northern South America, *Sarracenia* in southeastern North America, and *Darlingtonia* in California and Oregon. Recent molecular studies suggest that *Darlingtonia* should be sister to both *Heliamphora* and *Sarracenia* (Albert *et al.* 1992; Bayer *et al.* 1996; Neyland & Merchant 2006). Morphologically, their pollen have been studied with compound microscopes (Thanikaimoni & Vasanthy 1972) and some seeds have been briefly measured and described (McDaniel 1971; Maguire 1978; Godfrey & Wooten 1981; Ellison 2001; Schnell 2002), but they have not been well documented with SEM photos yet. As an attempt, we have used the LV model of Joel SEM to observe sarraceniacean anthers, pollen, and seeds. Rather than giving complete, detailed measurements, we present SEM photos of some sarraceniacean anthers, pollen, and seeds to demonstrate their similar and different characteristics, to be used to test the affinities among these geographically separated genera.

Material and Method

Reproductive organs of *Darlingtonia californica* were provided by Barry Rice (Davis, California, USA), while those of *Heliamphora* sp. were given by Andreas Wistuba (Mannheim, Germany). *Sarracenia purpurea* specimens were collected from Mount Davis Bog (Somerset, Pennsylvania, USA), while other *Sarracenia* species samples were from Meadowview Biological Research Station (Woodford, Virginia, USA). Specimens of seven species, *Sarracenia alabamensis*, *S. minor*, *S. oreophila*, *S. psittacina*, *S. purpurea*, *Darlingtonia californica*, and *Heliamphora* sp., have been collected and observed, although not all of their results are presented in this report. Samples were not treated but directly laid on double-side adhesive aluminum tape on SEM stubs. The JSM-6060LV was set with 15 kv, pressure 30 pa, spot size 50, and shadow 1.

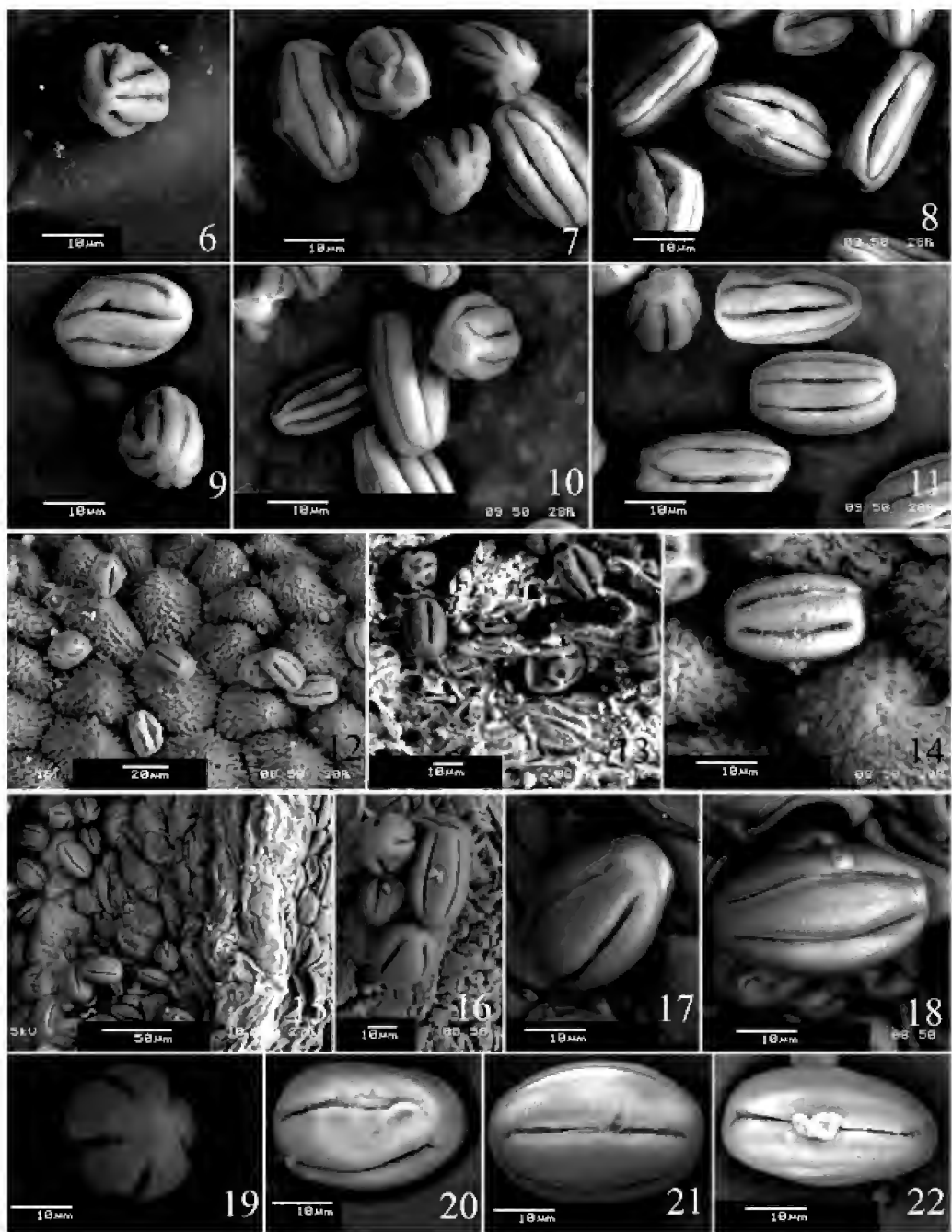
Results

Anthers, pollen, and seeds of the three sarraceniacean genera were photographed with SEM. Anthers (see Figures 1-5) are morphologically very different from each other. All anthers have two pollen sacs and two longitudinal dehiscent slits. Anthers of *Heliamphora* sp. are the longest among all three genera, up to 7.5 mm long, and each pollen chamber is about 1 mm in diameter (see Figure 1). The samples were received without the bottom part where should connect the filament. The anther dehiscent slit runs from the tip (see Figure 1b) through the bottom. The pollen sac is very thick, and the outside is covered with small round bumps (see Figure 1c), but some of them are so densely packed that they deformed from round to polygonal (see Figure 12). Each is about 30~40 μm in diameter and covered with erect flake-like structures (see Figures 12, 14). The inside of pollen sac has pollen and degenerated cells (see Figure 13). The anther of *Darlingtonia californica* has a tetra-angular cross view. It is about 4.0~4.5 mm long, about 0.5 mm wide (see Figure 2b), and the lateral side is about 0.8 mm wide (see Figure 2a). The filament bears the anther at about 1/5 anther length to the bottom (see Figure 2a). The outer surface is covered with crowded bumps that are relatively smooth (see Figure 15 left side), but the inside of pollen sac is filled with pollen and flattened-ball-like degenerated cells (see Figures 16-18). Anthers of *Sarracenia* are the shortest among all three genera. Among five observed species, anthers range from 1.36 to 3.89 mm long and the outer diameter of pollen sacs are 0.3 to 1.3 mm (Table 1). Filament is attached to the center on the backside of the anther (see Figure 3 arrow). Dehiscent slits initially open from the top to certain length downwards (see Figure 5), but eventually open fully (see Figure 4), flat or flipping outwards (see Figures 4-5, Table 1). Outer surface has reticulated structure and inner surface has horizontal striations (see Figures 4-5).



Figures 1-5: Sarraceniacean anthers. 1, *Heliamphora* sp.: a, dorsal view; b, ventral view with dehiscent part; c, inner side (left) and inward-curving pollen chamber edge. 2, *Darlingtonia californica*: a, side view; b, ventral view. 3, *Sarracenia alabamensis*: the arrow pointing at the remnant of filament in the middle of dorsal side. 4-5, *Sarracenia purpurea*: ventral views.

All observed pollen grains are in the same colporate type, but in different sizes, and with different numbers of colpi. Both *Heliampora* sp. (see Figures 12-14) and *Darlingtonia californica* (see Figures 15-22) have pollen grains with 4-6 colpi, but most pollen of the former have 4 colpi and the latter are mostly pentocolpate. Pollen of *Sarracenia purpurea* have 6-8 colpi (see Figures 6-11), mostly have 7 colpi. All taxa have the pollen in the similar shape, ranging from isopolar, prolate, oblate, to spheroidal, depending on their maturity. Young pollen grains are elongated or oblate, while fully developed pollen grains are in isopolar oval to spheroidal shapes. Colpi are mostly straight, but some of them are twisted (see Figure 9). Pollen grains of *Darlingtonia* and *S. purpurea* have smooth surface, but those of *Heliampora* sp. have tiny bumps, especially along the apertures (see Figure 14).



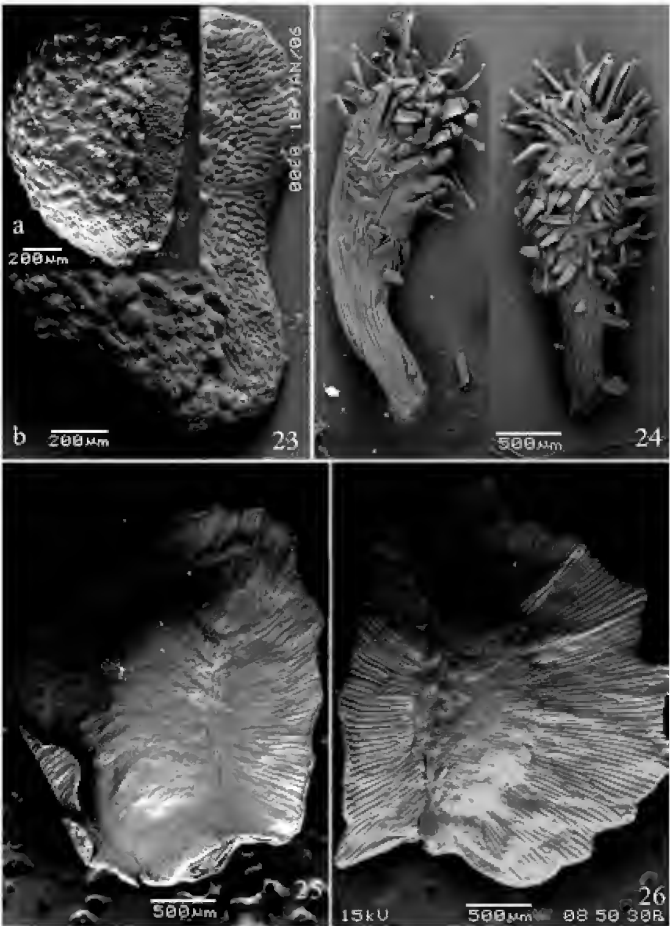
Figures 6-22: Sarraceniacean pollen. 6-11, pollen of *Sarracenia purpurea* in the same magnification. 12-14, *Heliampora* sp.: 12 and 14, pollen grains on the outer surface of a pollen sac; 13, pollen grains and degenerated cells inside of a pollen sac. 15-22, *Darlingtonia californica*: 15, pollen grain on the outer bumpy surface (left side); 16-18, pollen on nutritious tissue or immature pollen inside of a pollen sac. 17-22, pollen in the same magnification.

Table 1. Some anthers of five species of *Sarracenia*.

Species	Length (mm)	Width (mm)	Dehiscence	
<i>Sarracenia alabamensis</i>	1.36~1.56	0.3	Entire length	Flat slit
<i>Sarracenia psittacina</i>	2.4	1.0	1.80 mm	Flat slit
<i>Sarracenia minor</i>	2.39	0.935	1.96 mm	Flip outwards
<i>Sarracenia purpurea</i>	2.74	1	1.5 mm	Flip outwards
<i>Sarracenia oreophila</i>	3.89	1.3	3.06 mm	Half outwards

* Data presented here are just based on a few typical sized anthers, not of a statistical study

Seeds of the three genera are very different in shape, but their core parts are roughly in the same size. Seeds of *Darlingtonia californica* are oblate, straight or curved, 1.3 mm in diameter and about 2 mm long, consisting of a 0.6~0.8 mm long bottom part with longitudinal ridges and a top part with elongated spines that are round-tipped and up to 500 μ m long and about 70 μ m in diameter (see Figure 24). The spines appear to be hollow and can be flattened. Seeds of *Sarracenia purpurea* are oblate or kidney-shaped, 1.6~2.1 mm long and 1~1.2 mm wide, reticulate-tuberculate, and winged on one side (see Figure 23). Each tubercle can be about 60~100 μ m in diameter, with reticulate bumpy meshes, each about 30 \times 50 μ m. The wing area has cells arranged more or less in radial rows (see Figure 23b). *Heliamphora* sp. has winged seeds (see Figures 25-26). Similar to *S. purpurea* seeds, the core part is in the same shape and similar size, and with similar sized tubercles (see Figure 26) but the surface is relatively smooth (see Figure 25). The wing is around the meridian plane edge, up to 1 mm wide, and consists of radially arranged, elongated cells; each can be up to 55 μ m wide and 750 μ m long (see Figure 26).



Figures 23-26: Sarraceniacean seeds. 23, *Sarracenia purpurea* seeds in different magnifications. 24, *Darlingtonia californica* seeds. 25-26, *Heliamphora* sp. seeds.

Discussion

Our morphological results are generally matched with previous reports, but demonstrated with much better photos. Seed size and morphology concur with previous reports (McDaniel 1971; Maguire 1978; Godfrey & Wooten 1981; Ellison 2001; Schnell 2002). *Heliamphora* sp. does not have tricolporate pollen as that of *H. heterodoxa*, but mostly have four apertures and thus differ from those of *H. nutans* and *H. tyleri* (= *H. tatei*), both are mostly pentocolporate (Thanikaimoni & Vasanthy 1972). Anthers of *Heliamphora* sp. are pretty long, much longer than *H. minor* (4 mm) and *H. ionasii* (3.5 mm), but in the same length of *H. hispida* (Nerz & Wistuba 2000). So, the specimen from Wistuba could be *H. hispida*.

As we mentioned earlier, this study is a preliminary comparative study of sarraceniacean anthers, pollen, and seeds, for finding similarities and differences to test relationships among the three genera. Traditionally, *Heliamphora* is thought to be primitive for having the simplest pitcher structures, but its flowers are the mostly derived in the whole family (Renner 1989). *Sarracenia* and *Darlingtonia* had been considered to be closer to each other because they share many characters and they are endemic to North America (Maguire 1978; Juniper *et al.* 1989). However, recent molecular data suggest that *Darlingtonia* is sister to a *Heliamphora*-*Sarracenia* clade (Albert *et al.* 1992; Bayer *et al.* 1996; Neyland & Merchant 2006).

As we have observed, anthers of the three genera are very different in length, shape, thickness, outer and inner surface structures, so they do not display clues of their affinity. On the other hand, their pollen grains are so highly similar to each other, and thus cannot indicate a closer relationship between any two of them. Although *Darlingtonia* and *Heliamphora* share slight similarities in having elongated and bumpy anthers, with 4-5 colporate pollen grains mostly, these are not significant enough to imply a closer inter-genera relationship. The seeds of the three genera appear to be very different, as they are spiny (*Darlingtonia*), winged (*Heliamphora*), or reticulate-tuberculate (*Sarracenia*). However, with a close examination, seeds of the latter two are found much more similar to each other. *Sarracenia* seeds have a narrow wing on one side, and the wing has cells arranged in more or less radial rows. *Heliamphora* seed has wings around the primary plane, and wings with radially elongated cell tiers. Both genera have the seed core parts in the similar size and with reticulate-tuberculate surface (even the tubercles are in the similar size and shape), although *Heliamphora* sp. seeds have fewer tubercles. *Darlingtonia* seeds do not have any reticular tubercles, but elongate ridges and spines. Therefore, seed morphology suggests that *Heliamphora* and *Sarracenia* could be related to each other more closely than to *Darlingtonia*, thus supporting the hypothesis that *Darlingtonia* is sister to the *Heliamphora*-*Sarracenia* clade.

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BOOK REVIEW

By Jan Schlauer

Catalano, M. "Nepenthes della Thailandia – Diario di viaggio" (*Nepenthes* of Thailand – Travel Diary, text in Italian, descriptions of new taxa in Latin/English) 207 pp., 209 col. photos, 1 line drawing, 13 maps, hard cover, published February 2010 by the author (Marcello Catalano, via Ronchi 2, 20134 Milano, Italy, <rafflesiana@yahoo.com>); 30 € (ca. 40 US\$)

In a narrative style that only Italians master ("se non è vero, è ben trovato"), the author describes his remarkable experience from roughly a decade of training and research both at herbaria and in the field. The present work is understood as a contribution to the knowledge of the genus *Nepenthes* in the whole region of Indochina, so there is potential for future supplements covering Burma (Myanmar), Laos, Vietnam, and Cambodia. Taxonomy is presented here as learning by travel, observation, and discovery, and the author also does not spare the reader the frustrating experience when herbarium/literature-based expectations were disappointed by an adverse field reality.

The diversity of the genus in Thailand as featured in the present book is far greater than expressed by any previous author. Five new taxa are described (*N. andamana*, *N. chang*, *N. kerrii*, *N. mirabilis* var. *globosa*, *N. suratensis*), and one further is introduced as a *nomen nudum* ("ined.") as its formal description is credited to yet unpublished work by Martin Cheek (Kew Gardens, UK).

According to recent research at Kew, *N. smilesii* (type from Thailand or Laos; so far the type locality "Baw Saw" does not seem to have been located precisely, and "Northern Siam" covers territory of both contemporary countries) is the correct name for the species that has been called *N. anamensis* (type from Vietnam) before. Most of the Thai taxa are said to be close relatives of the recently described *N. bokorensis* (type from Cambodia) that is intermediate between *N. smilesii* and *N. thorelii* (type from Vietnam). It is thus most unfortunate that neither *N. bokorensis* nor *N. thorelii* is featured in the present book in detail, but they apparently have not been found in Thailand so far. Differences in indumentum, leaf shape, peristome width, presence/absence of bracteoles in the inflorescence, and androphore length are used to distinguish individual taxa in this complex aggregate.

Of the five new taxa, one is classified as a variety of *N. mirabilis* with large ovoid pitchers. This *N. mirabilis* var. *globosa* is the plant that has informally been called "Viking" in cultivation.

An English translation of this book is announced (in <http://www.carnivorousplants.it/indochina.htm>) to be published in 3-4 years.

Limited Edition Books

The last **first edition** copies of the following books by Stewart McPherson are available from www.redfernnaturalhistory.com.

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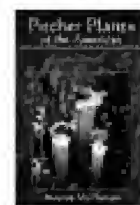
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Sarracenia 'Alucard' T.H.Wyman, Carniv. Pl. Newslett. 38:13 (2009), reg. Dec. 26.
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Sarracenia 'Birds Beak' N.Haywood ex P.Sheridan, Meadowview Biol. Res. Sta. 2009 Cat.: 19 (2009), reg. Jul. 1.
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